

*Po. # 36*

MPAD 5407 S

# APOLLO 11 MISSION SUMMARY

17 JUNE 69  
J. R. GURLEY

# INTRODUCTION

- OPERATIONAL TRAJECTORY CHANGES
  - ADDITIONAL REV PRIOR TO DOI
  - JULY 18, 21 LAUNCH WINDOW REDUCTION AND BUILT-IN MCC
  - BIAS LOI TARGETING
  - ADDITIONAL REV PRIOR TO TEI
- JULY LAUNCH WINDOW SUMMARY
- LUNAR POTENTIAL EFFECTS
- DESCENT OPERATIONAL STATUS
- CONSUMABLES SUMMARY

MPAD 54355(14)

# LAUNCH WINDOW EFFECT FOR 210 FEET PDI COVERAGE

	JULY		
	16	18	21
DELAY REQUIRED WITH CURRENT TIMELINE, HR:MIN	1:05	5:20	5:30
DELAY REQUIRED WITH ONE EXTRA LPO REV, HR:MIN	0	3:20	3:30
TLMCC $\Delta V$ REQUIRED WITH 2 1/2 HR LAUNCH WINDOW AND ONE EXTRA REV, FPS		TLI + 9 <sup>h</sup> 90 TLI + 24 <sup>h</sup> 130	TLI + 9 <sup>h</sup> 100 TLI + 24 <sup>h</sup> 140
LAUNCH AZIMUTH RANGE FOR 2 1/2 HR WINDOW, DEG	72 108	89 108	94 108

# JULY LAUNCH WINDOW CONFIGURATION

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LAUNCH  
DATE

16

08:32 TO 12:54

1/2 HR AFTER  
SUNSET →

18

10:32  
TO  
13:02

21

← 1/2 HR BEFORE  
SUNRISE

11:09  
TO  
13:39

LAUNCH  
AZIMUTHS

LDG  
SITE

SUN EL AT  
LANDING  
SITE

72° - 108°

2

1ST 2ND  
10.8 11.6

↓ ↓  
12.9 13.6

89° - 108°

3

11.0 11.0

↓ ↓  
11.3 12.0

94° - 108°

5

9.1 9.1

↓ ↓  
9.7 10.0

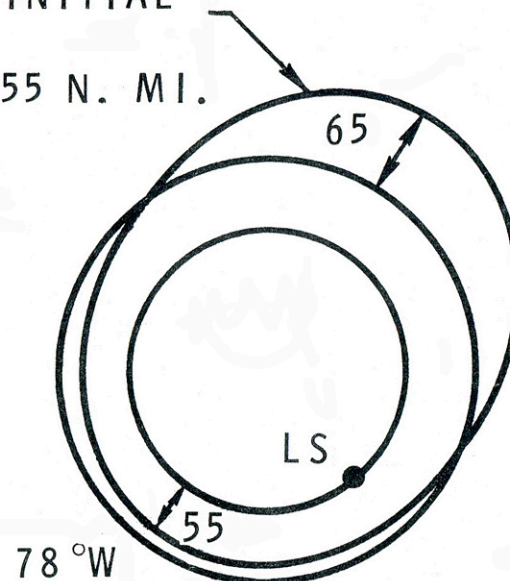
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

LAUNCH TIME - EASTERN STANDARD

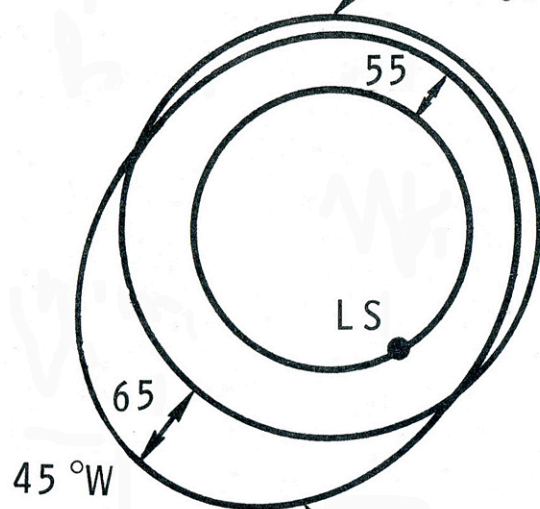


## LUNAR POTENTIAL EFFECT ON ALTITUDE

LOI-2 INITIAL  
ORBIT  
65 BY 55 N. MI.



LOI-2 INITIAL  
ORBIT  
~60 BY 60 N. MI.

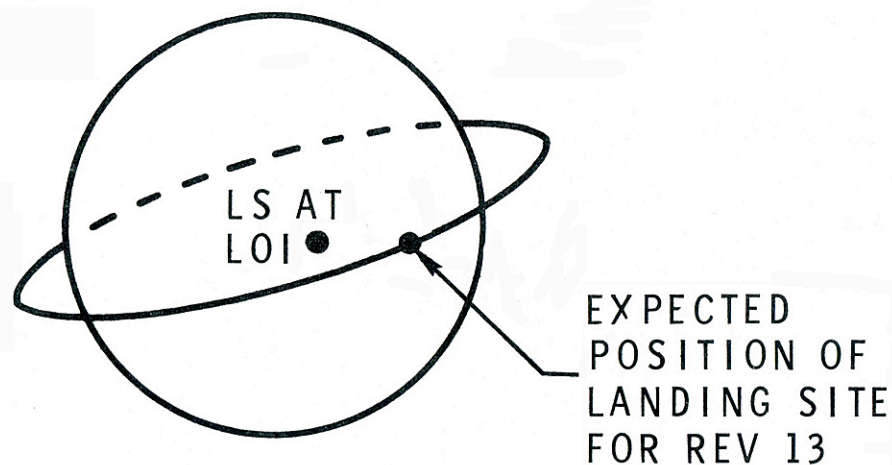


CSM ORBIT AT  
LM RENDEZVOUS  
~65 BY 55

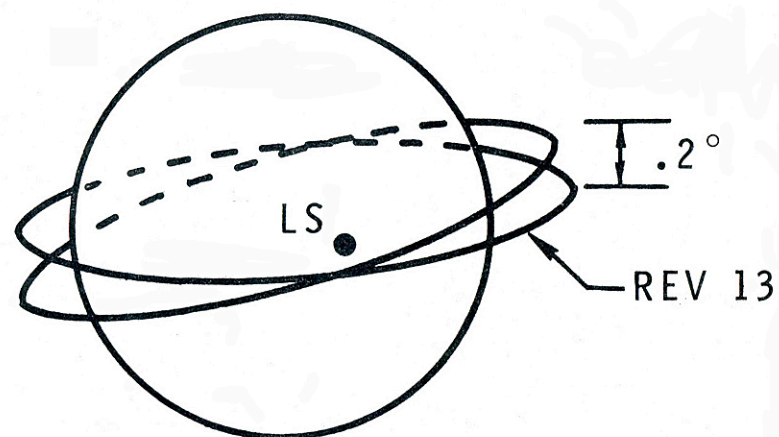
CSM ORBIT AT  
LM RENDEZVOUS  
~60 BY 60

# LUNAR POTENTIAL EFFECT ON GROUNDTRACK

NOTE: THE ORBIT INCLINATION IS EXAGGERATED. ACTUAL INCLINATION IS  $\approx 1^\circ$



ORBIT PLANE ROTATES  
WITH MOON

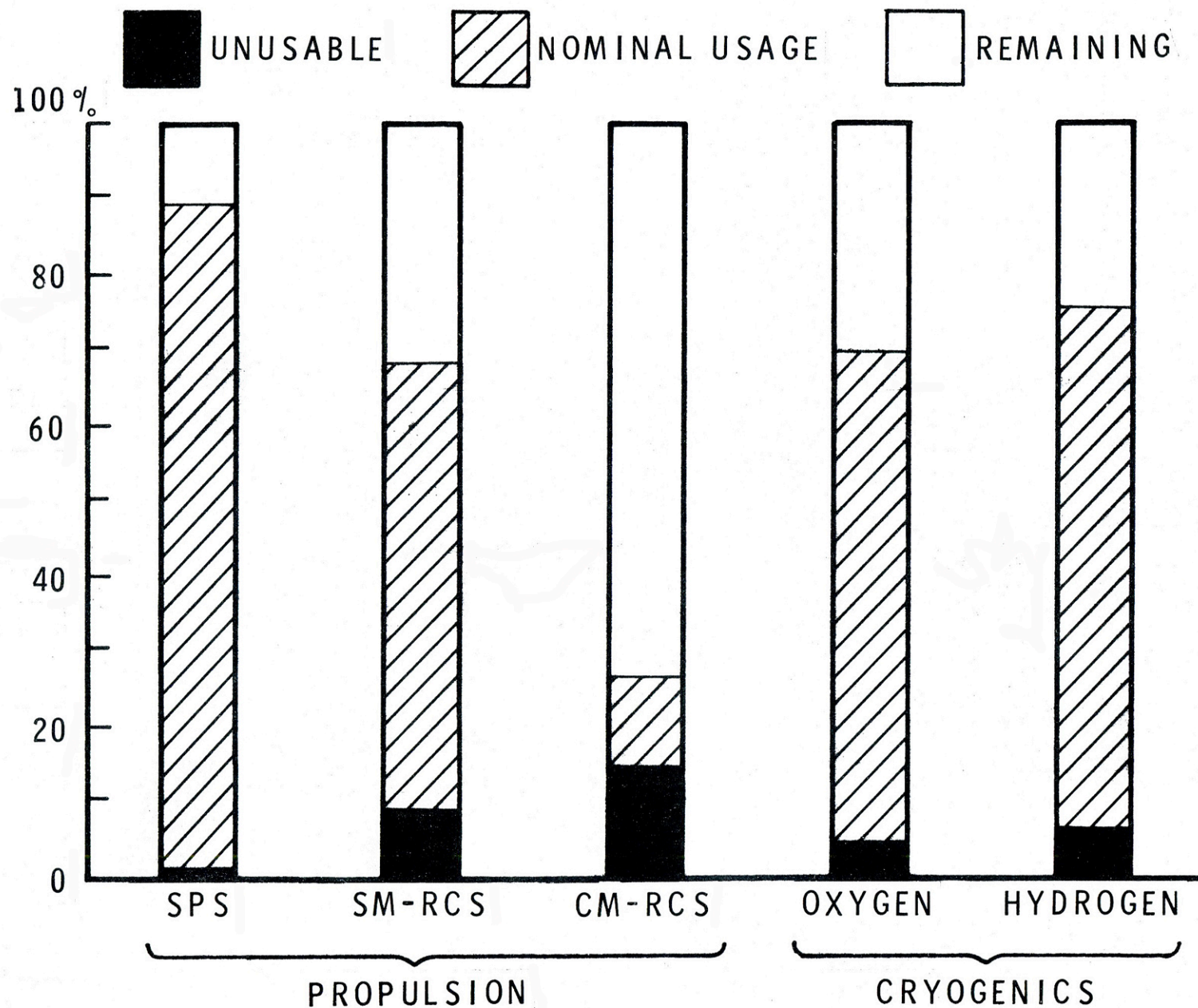


ORBIT PLANE INCLINATION  
ROTATES TOWARD THE  
EQUATOR

# DESCENT TRAJECTORY STATUS

- NAVIGATION
  - MODELS AND TECHNIQUES HAVE BEEN VERIFIED
- LANDING ACCURACY
  - LATEST NAVIGATION AND SYSTEMS ERRORS RESULTS IN SEMI-MAJOR AXES OF 3.4 AND 1.3 N. MI.
- TRAJECTORY TARGETING
  - FINE ADJUSTMENTS FOR RECENT CHANGES IN ENGINE PERFORMANCE, LANDING RADAR NOISE AND TERRAIN SLOPE
- GUIDANCE
  - STABLE
- PROPELLANT
  - ADEQUATE

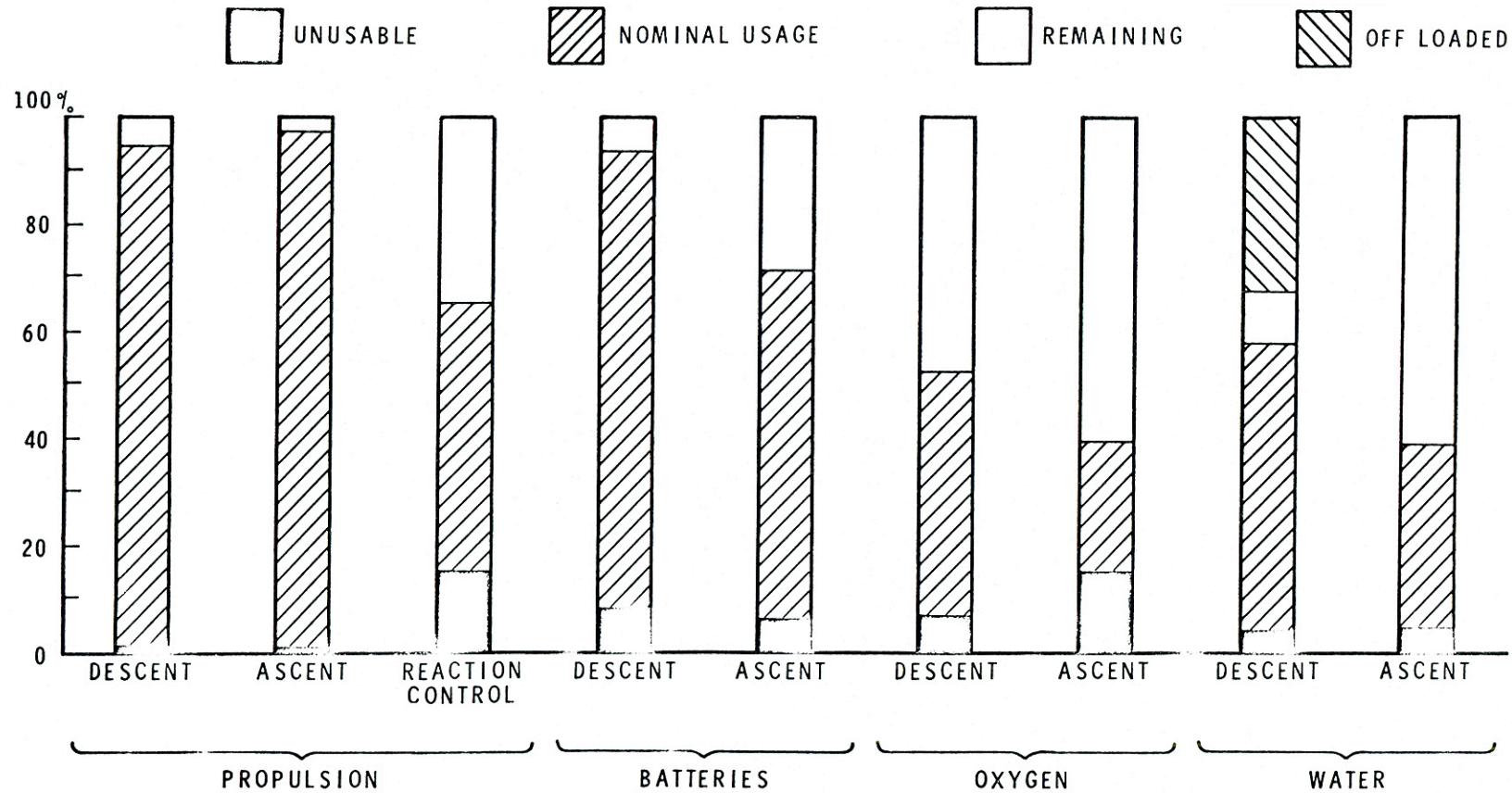
# APOLLO 11 (CSM 107) CONSUMABLES SUMMARY





# APOLLO 11 (LM-5) CONSUMABLES SUMMARY

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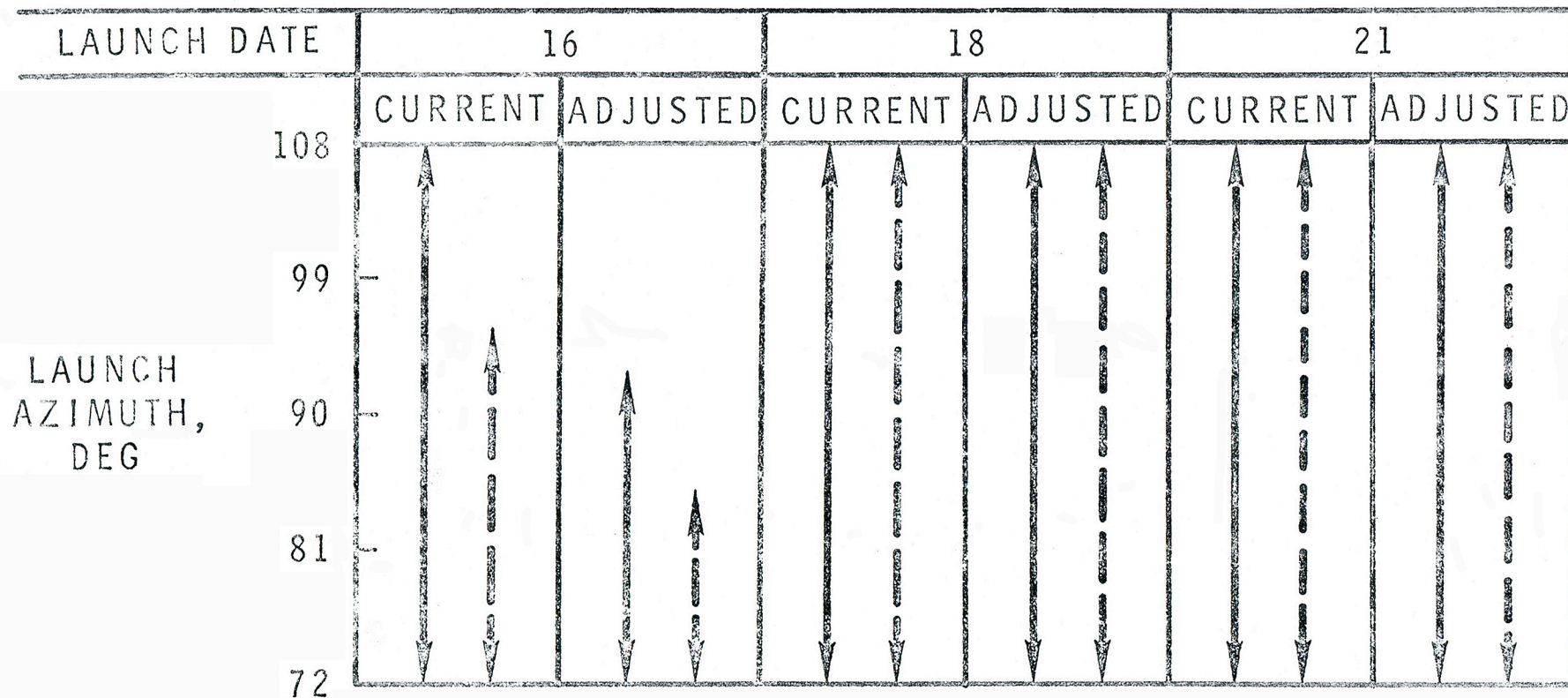
# BACK-UP CHARTS

## LAUNCH WINDOW OPERATIONAL GUIDELINES

- 3 POSSIBLE LAUNCH DAYS ACROSS A 6 DAY PERIOD WITH 1, 3 AND 6 TYPE SPACING
- DAYLIGHT LAUNCH
- PACIFIC INJECTION
- LUNAR LIGHTING AT LANDING
  - $5^{\circ}$  -  $14^{\circ}$  PREFERRED
  - $14^{\circ}$  -  $18^{\circ}$  UNACCEPTABLE
  - $18^{\circ}$  -  $20^{\circ}$  ACCEPTABLE
- DAYLIGHT LANDING

MPAD 5427 S(14)

# EFFECT ON EVA COVERAGE FOR JULY LAUNCH WINDOW



LAUNCH  
AZIMUTH,  
DEG

— 1<sup>st</sup> INJECTION OPPORTUNITY  
- - - 2<sup>nd</sup> INJECTION OPPORTUNITY



# MISSION SUMMARY

## JULY 16, 72° - 1

	G.E.T. HR:MIN
LAUNCH	0:00
TRANSLUNAR INJECTION	2:44
SPS EVASIVE MANEUVER	4:39
LOI-1	75:55
LOI-2	80:12
UNDOCKING	100:13
DOI	101:42
PDI	102:38
LANDING	102:50
ASCENT	124:28
DOCKING	128:14
TEI	135:28
TOUCHDOWN	195:15

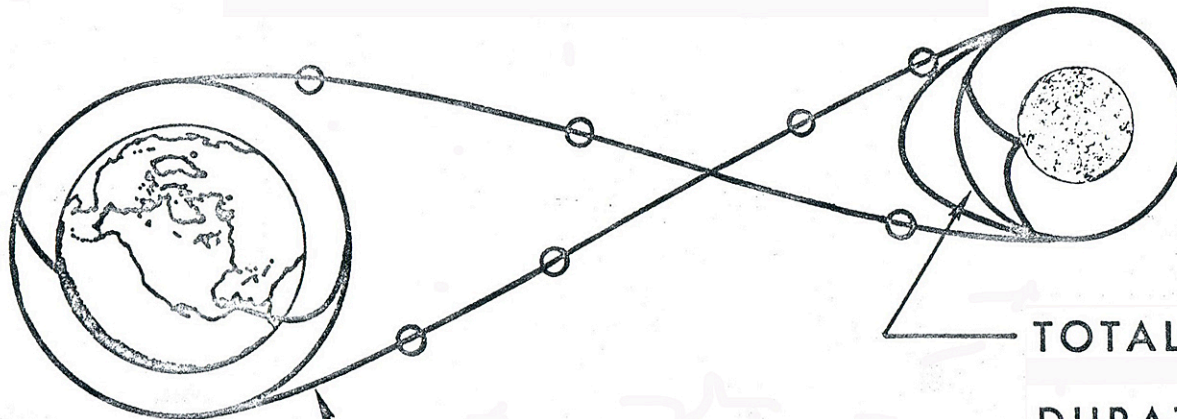
# MISSION PROFILE

LOI-1 60 BY 170 N. MI.

LOI-2 65 BY 55 N. MI.

LUNAR SURFACE STAY TIME 21.5 HR

TRANSEARTH COAST ~ 60 HR



TOTAL LPO

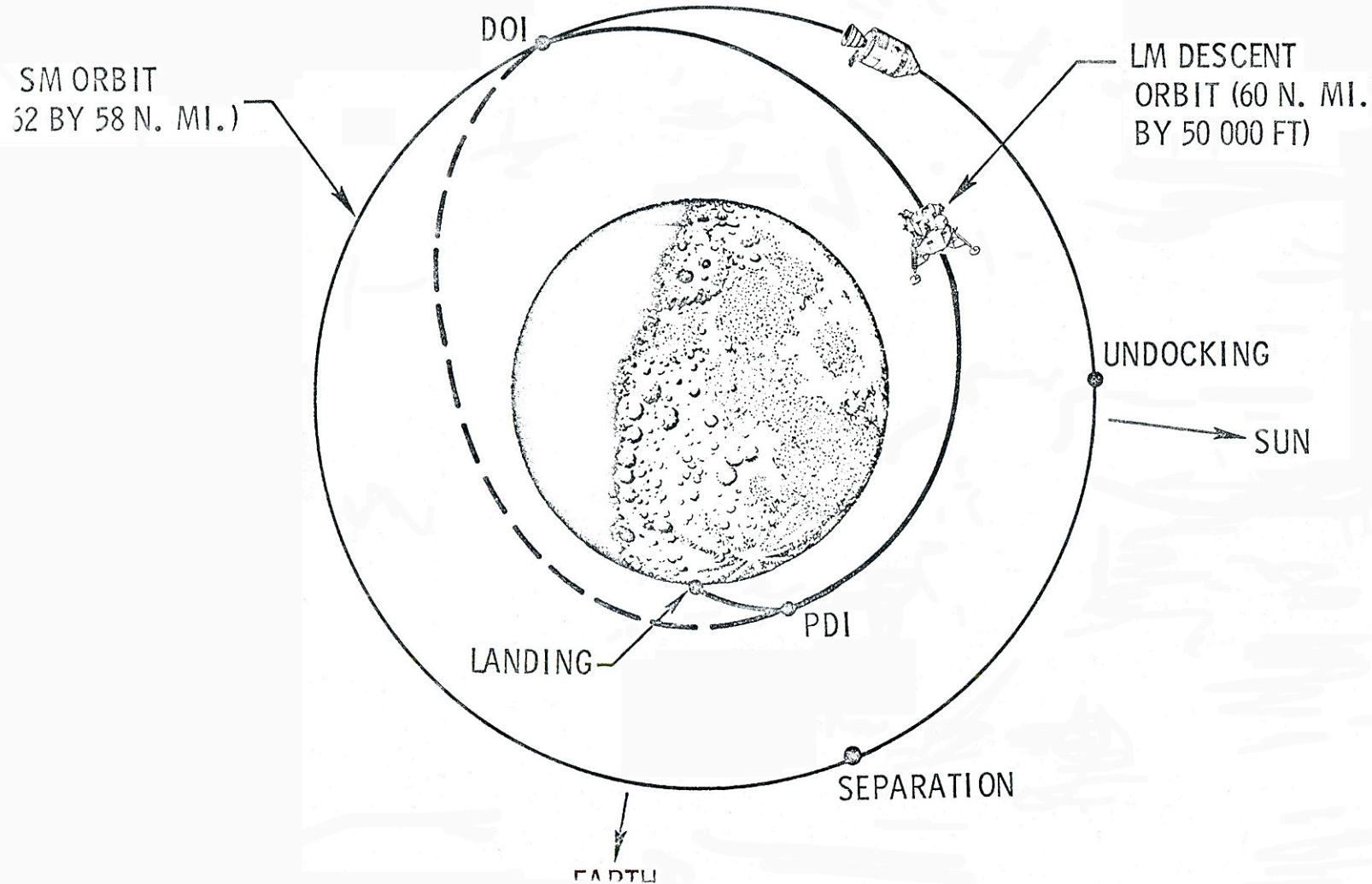
DURATION ~ 59.5 HR

TRANSLUNAR COAST ~ 76 HR

INJECTION INTO  
TRANSLUNAR  
TRAJECTORY

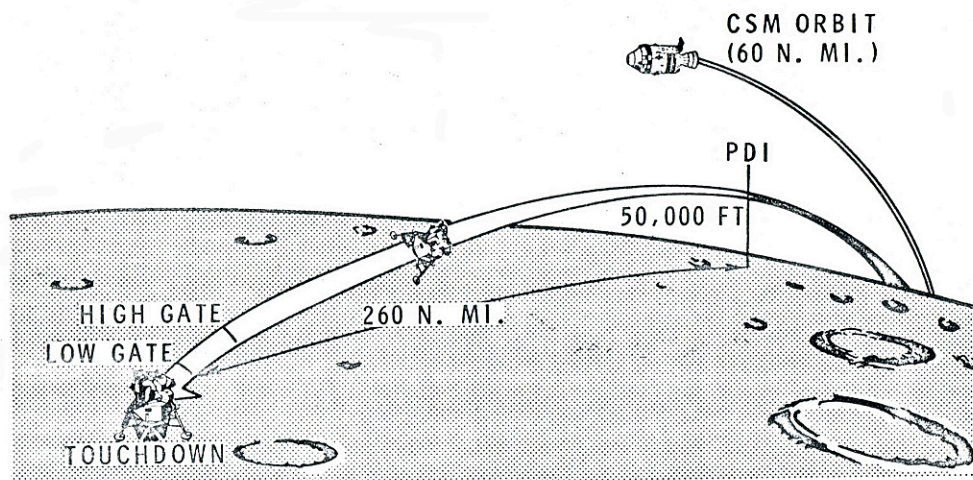
○ = MIDCOURSE CORRECTION

# LM DESCENT



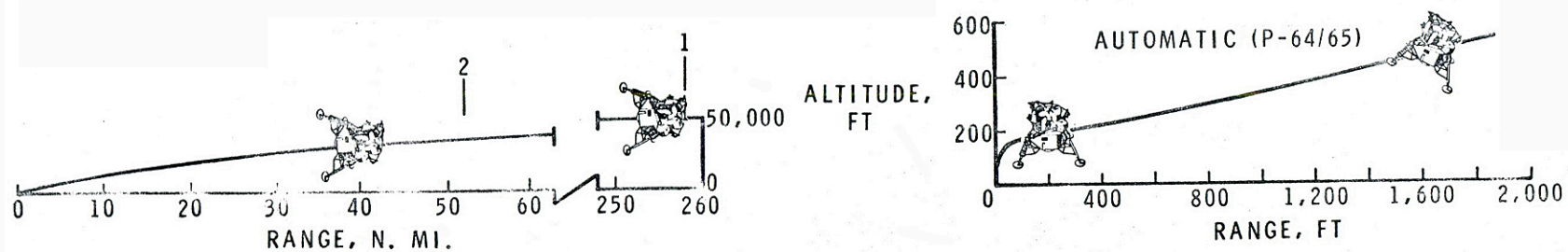


# OPERATIONAL PHASES OF POWERED DESCENT



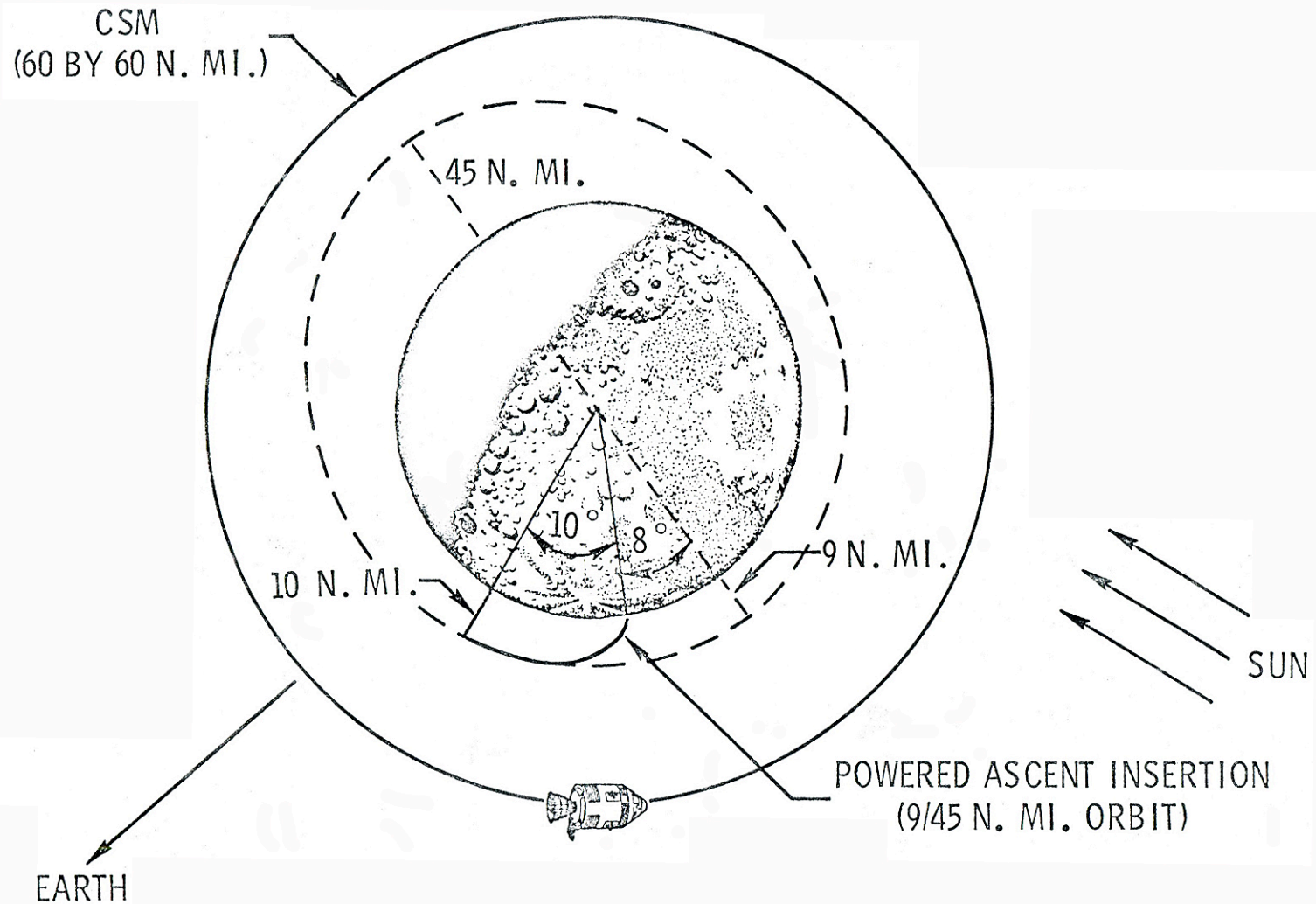
## (LANDING PHASE)

EVENT	TIME, MIN	ALTITUDE, FT	RANGE, N. MI.	PITCH, DEG
1 IGNITION	0	50,000	258	92
2 RADAR ALTITUDE UPDATE	5	36,000	52	74

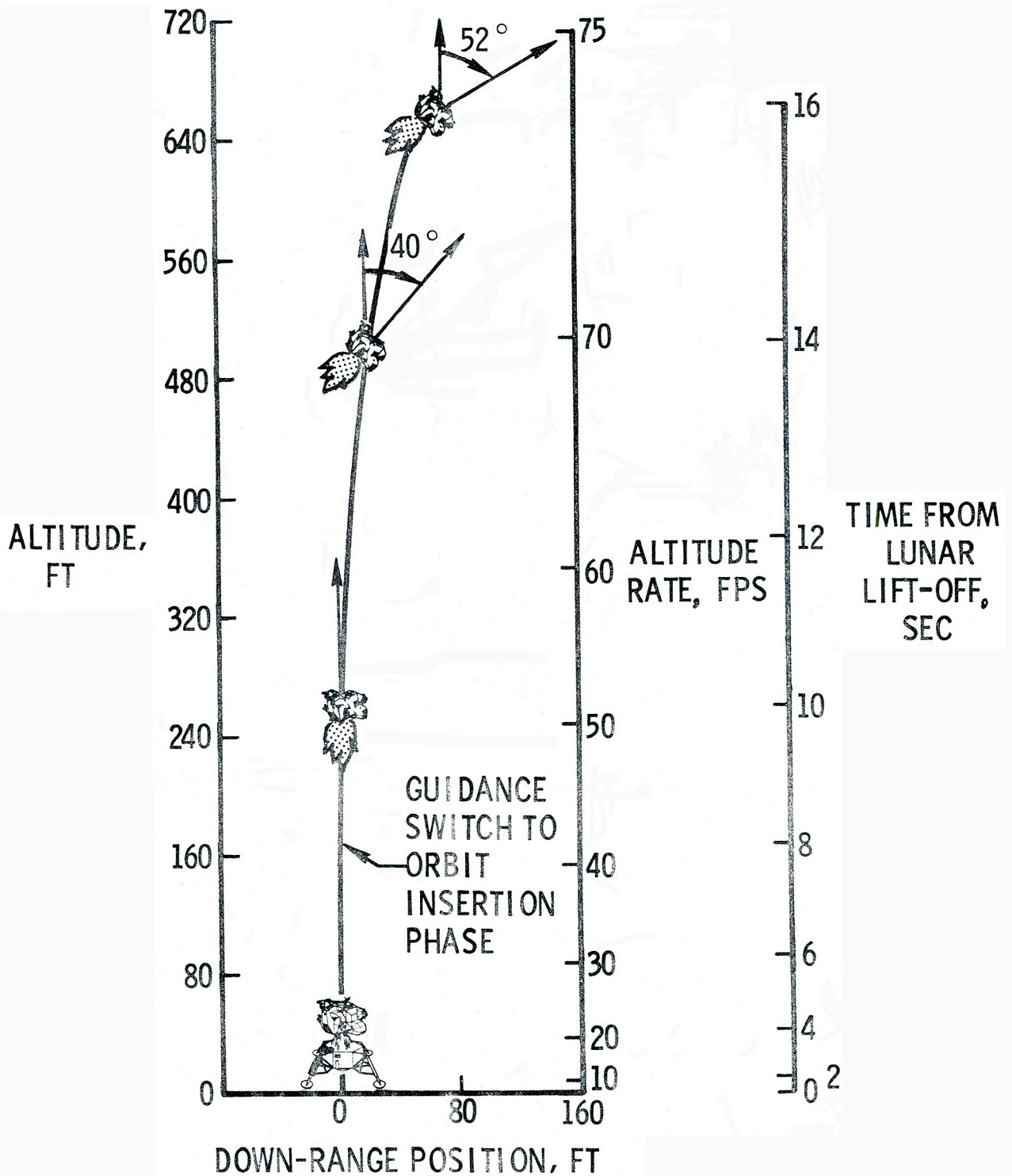




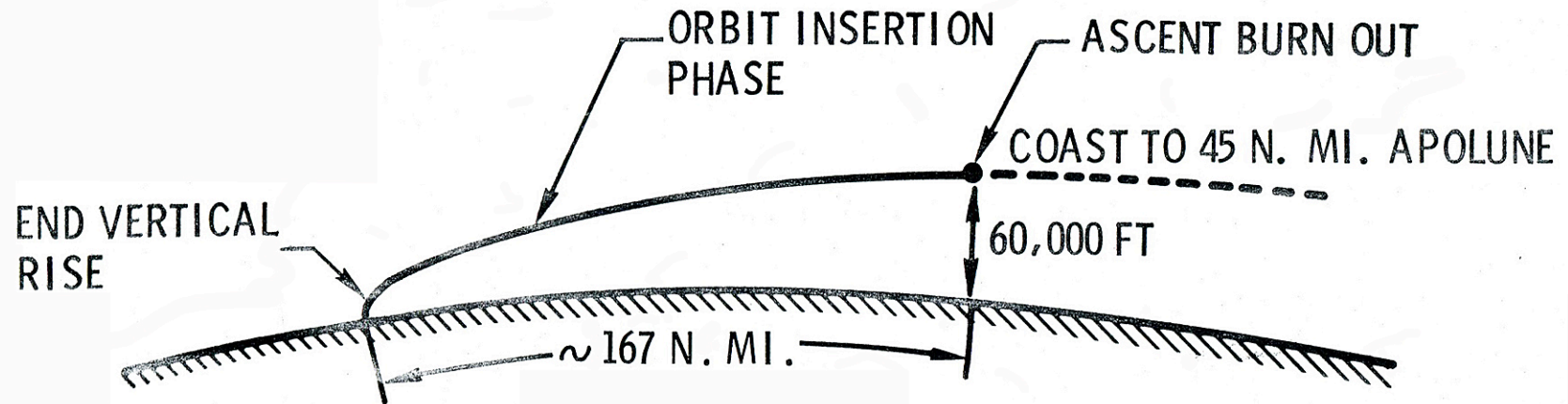
# LM ASCENT



## VERTICAL RISE PHASE

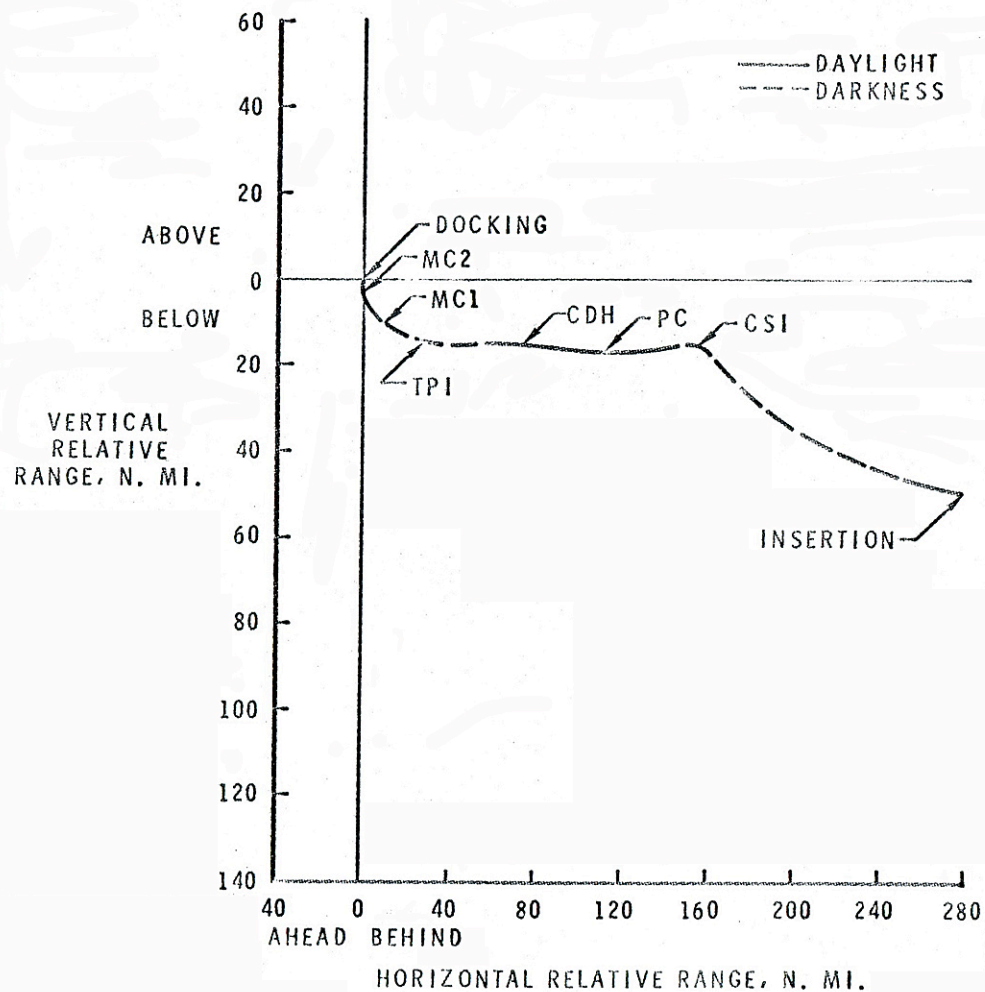
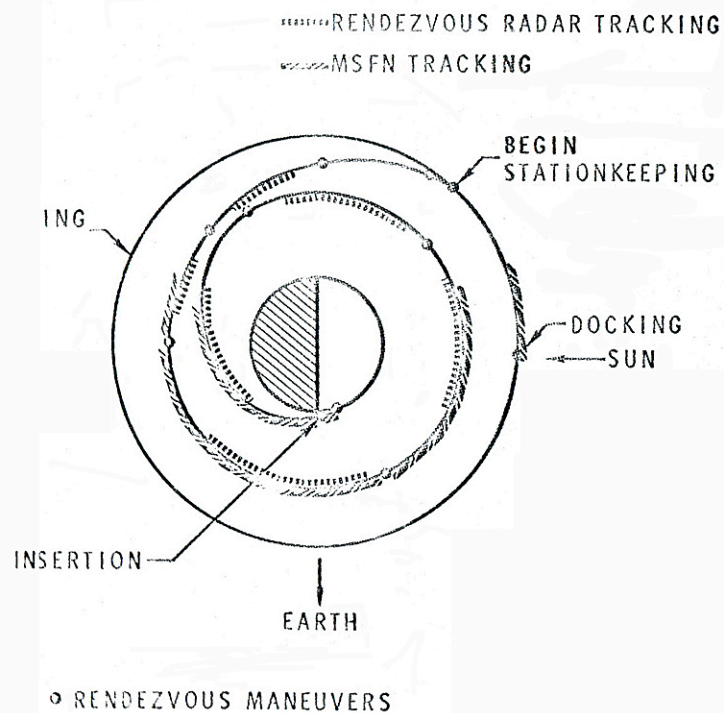


## ORBIT INSERTION PHASE



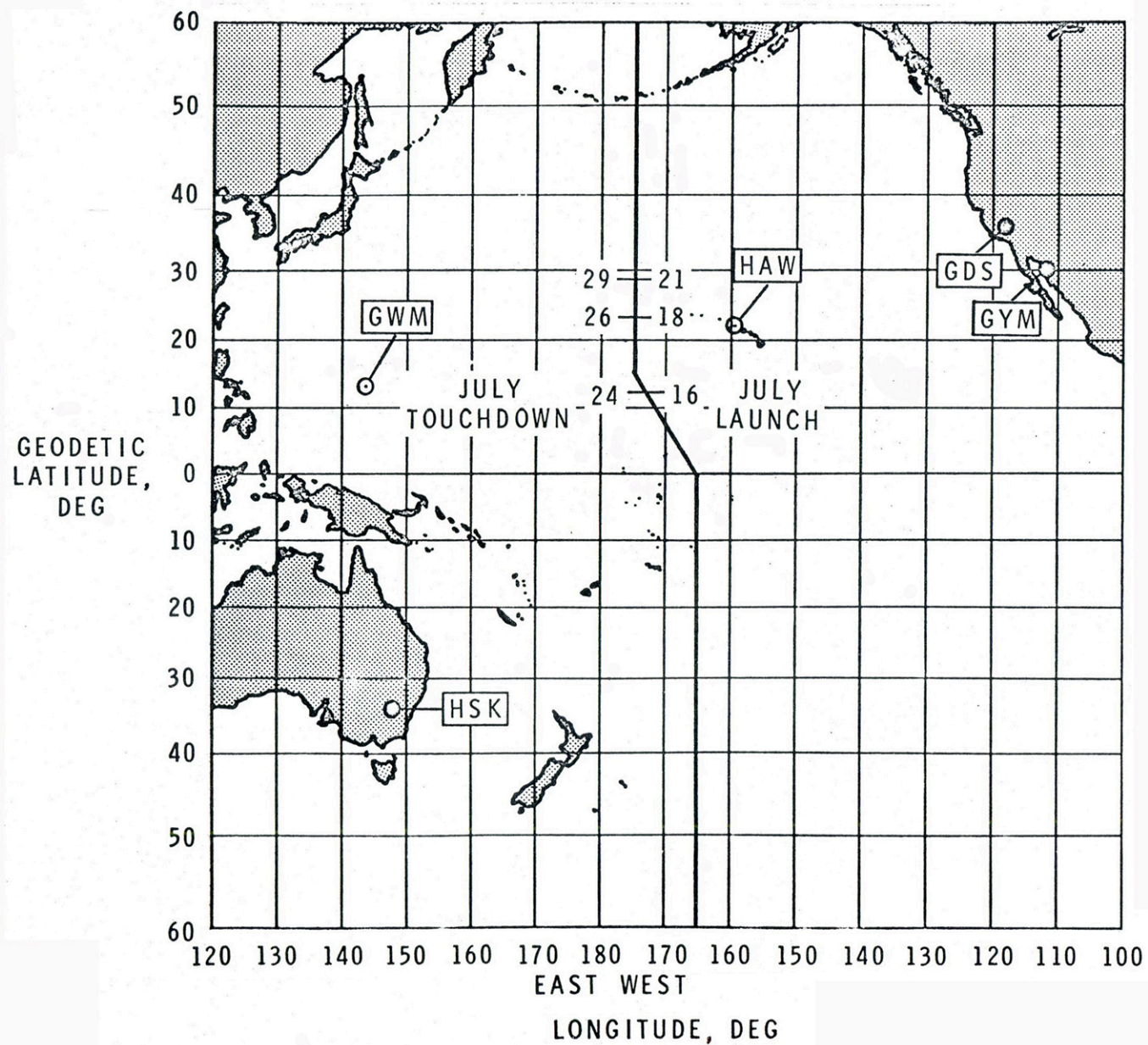
TOTAL ASCENT:  
 BURN TIME = 7:16 MIN:SEC  
 $\Delta V$  REQUIRED = 6,063 FPS  
 PROPELLANT REQUIRED = 4,949 LBS

## RENDEZVOUS AND RELATIVE MOTION





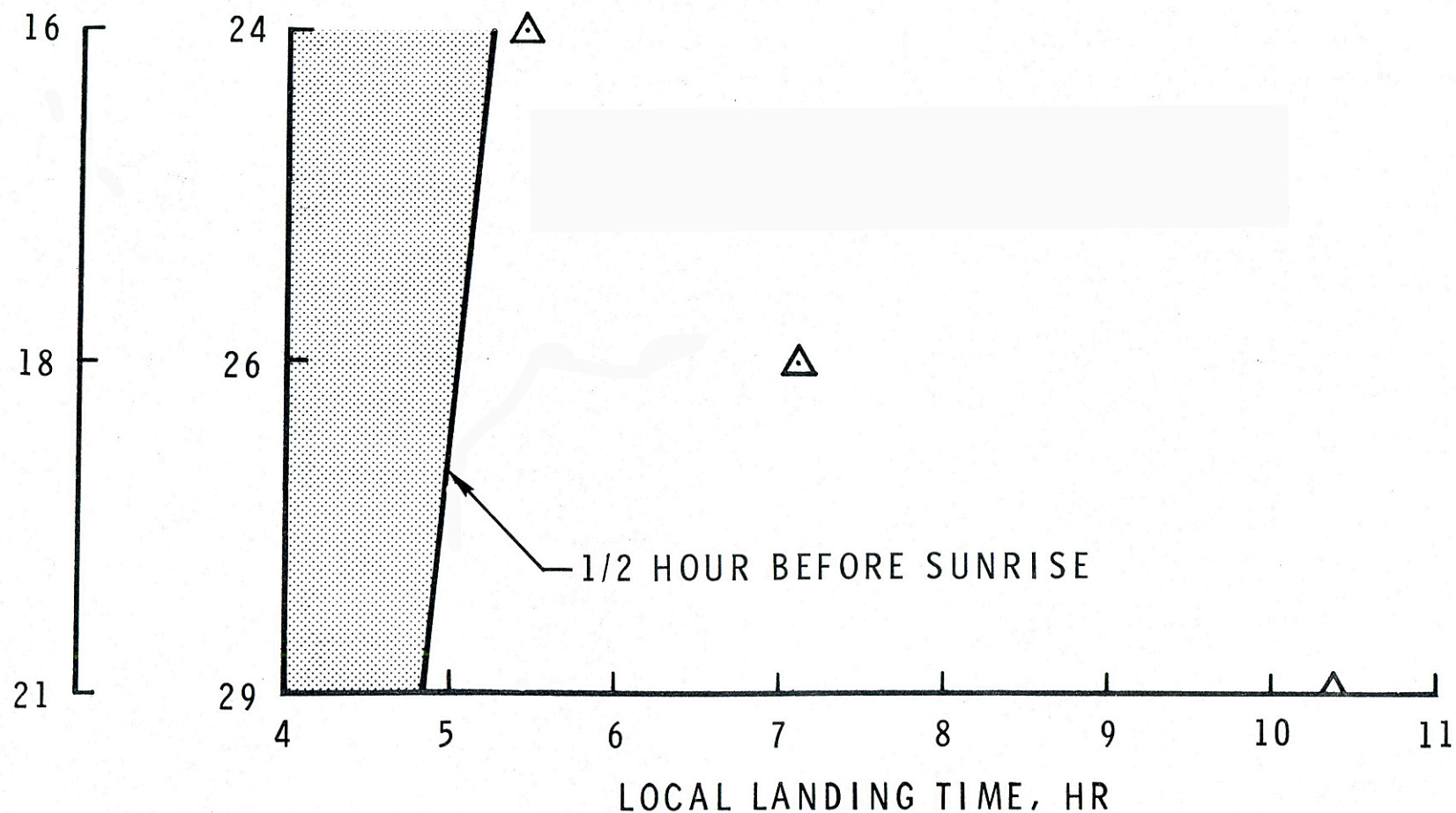
## JULY WINDOW NOMINAL RETURN LOCI



# RETURN LIGHTING CONDITIONS (JULY LAUNCH)

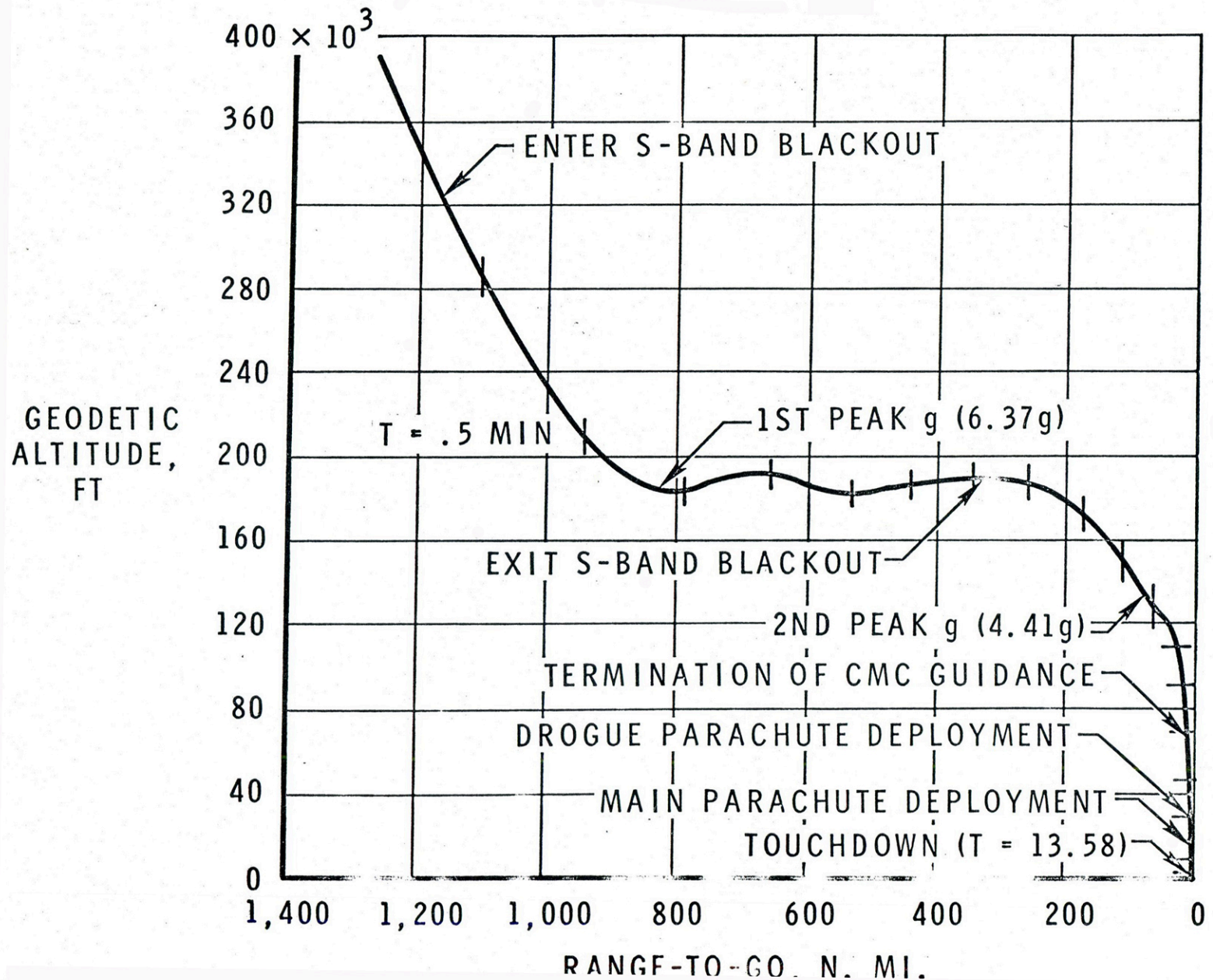
LAUNCH DATE  
JULY 1969

LANDING DATE  
JULY 1969



# ENTRY

MPAD 5418 S





# APOLLO 11 SPS PROPELLANT SUMMARY

ITEM	PROPELLANT REQUIRED, LB	PROPELLANT REMAINING, LB
LOADED		40,795.7
TRAPPED AND UNAVAILABLE	441.4	40,354.3
OUTAGE	59.5	40,294.8
UNBALANCE METER	100.0	40,194.8
AVAILABLE FOR $\Delta V$		40,194.8
REQUIRED FOR $\Delta V$		
TLMC (120 FPS)	1,166.4	39,028.4
LOI(1) (2,924 FPS)	23,865.2	15,163.2
LOI(2) (158 FPS)	1,116.7	14,046.5
LOPC (17 FPS)	73.8	13,972.7
TEI (3,290 FPS)	10,069.7	3,903.0
NOMINAL REMAINING		3,903.0
MISSION FLEXIBILITY (900 FPS)	2,212.7	1,690.3
DISPERSIONS ( $-3\sigma$ )	622.2	1,068.1
PROPELLANT MARGIN		1,068.1



MPAD 5429 s(14)

## APOLLO 11 LM DESCENT PROPELLANT SUMMARY

### ● ASSUMPTIONS

- SPECIFIC IMPULSE =  $301.7 \pm 3.225$  SEC
- MIXTURE RATION =  $1.597 \pm .01125$
- NOMINAL  $\Delta V$  =  $6,760.2 \pm 132.0$  FPS
- LM WEIGHT AT SEPARATION = 33,715.0 LB

### ● NON $\Delta V$ CONSUMABLES

- 42 LB FROM SEPARATION TO DOI
- $105 \pm 29.5$  LB FROM DOI TO TOUCHDOWN

MPAD 54-335 (10)

## REACTION CONTROL SYSTEM BUDGET

### ● RESULTS

	PROPELLANT, LB
● LOADED	633
● UNUSABLE	97
● AVAILABLE	536
● REQUIRED	266
● NOMINAL REMAINING	270
● DISPERSIONS	129
● MARGIN	141

# APOLLO 11 LM DESCENT PROPELLANT SUMMARY

RESULTS	<u>FUEL, LB</u>	<u>OXIDIZER, LB</u>	<u>TOTAL, LB</u>
• SYSTEM CAPACITY	7,051.2	11,209.3	18,260.5
• OFFLOAD	-76.2		-76.2
• LOADED	6,975.0	11,209.3	18,184.3
• UNUSABLE			-239.9
• AVAILABLE			17,944.4
• NOMINAL REQUIRED FOR $\Delta V$ (6,760.2 FPS)			-16,849.4
• REMAINING			1,095.0
• MINUS $3\sigma$ DISPERSIONS			-266.6
• PAD			828.4
• CONTINGENCIES, LB			
• ENGINE MALFUNCTION ( $\Delta MR = \pm 0.016$ )		-72.8	
• REDLINE LOW-LEVEL SENSOR		-68.7	
• REDESIGNATION (60 FPS)		-103.6	
• MANUAL HOVER (167 FPS)		-284.9	
• TOTAL CONTINGENCY		-530.0	
• MARGIN			298.4

MPND 5430 S(1A)

## APOLLO 11 LM ASCENT PROPELLANT SUMMARY

### ● ASSUMPTIONS

- SPECIFIC IMPULSE =  $308.97 \pm 3.553$  SEC
- MIXTURE RATIO =  $1.602 \pm .0225$
- NOMINAL  $\Delta V$  =  $6,063.0 \pm 40.0$  FPS
- ASCENT STAGE LIFT-OFF WEIGHT = 10,849.4 LB



MPAD 5425 S(14)

## APOLLO 11 LM ASCENT PROPELLANT SUMMARY

### RESULTS

	<u>FUEL, LB</u>	<u>OXIDIZER, LB</u>	<u>TOTAL, LB</u>
• SYSTEM CAPACITY	2,026.0	3,218.4	5,244.4
• OFFLOAD	<u>-6.0</u>		<u>-6.0</u>
• LOADED	2,020.0	3,218.4	5,238.4
• UNUSABLE			<u>-66.6</u>
• AVAILABLE			5,171.8
• NOMINAL REQUIRED FOR $\Delta V$ (6,063.0 FPS)			<u>-4,949.1</u>
• REMAINING			227.7
• MINUS 3 $\sigma$ DISPERSIONS			<u>-59.2</u>
• PAD			163.5
• CONTINGENCIES, LB			
• ENGINE MALFUNCTION ( $\Delta MR = \pm 0.016$ )			-19.6
• PGNCs TO AGS SWITCHOVER (40 FPS)			-23.7
• ABORT FROM TOUCHDOWN ( $\Delta \Delta V = -13.6$ FPS AND $\Delta W = 129.9$ LB)			<u>-51.3</u>
• TOTAL CONTINGENCIES			-94.6
• MARGIN			68.9

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## LM WATER BUDGET

### ● RESULTS

	<u>WATER, LB</u>
	<u>DESCENT</u>
● LOADED (AT LIFT-OFF)	210.6*
● UNUSABLE	<u>-16.3</u>
● AVAILABLE	194.3
● NOMINAL REQUIRED	<u>-177.9</u>
● REMAINING	16.4
● MINUS 3 SIGMA DISPERSIONS	<u>—</u>
● PAD	16.4
● CONTINGENCIES	<u>-14.0</u>
● MARGIN	2.4

\*DESCENT WATER OFFLOADED 122.4 LB